AN INTRODUCTION TO THE THEORY OF SPIN GLASSES AND NEURAL NETWORKS

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World Scientific Lecture Notes in Physics – Vol. 54

AN INTRODUCTION TO
**THE THEORY OF
SPIN GLASSES AND
NEURAL NETWORKS**

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Published by

World Scientific Publishing Co. Pte. Ltd.

P O Box 128, Farrer Road, Singapore 9128

USA office: Suite 1B, 1060 Main Street, River Edge, NJ 07661

UK office: 57 Shelton Street, London WC2H 9HE

Library of Congress Cataloging-in-Publication Data

Dotsenko, Viktor, 1957–

An Introduction to the theory of spin glasses and neural networks

/ Viktor Dotsenko.

p. cm. -- (World Scientific lecture notes in physics ; vol. 54)

Includes bibliographical references.

ISBN 9810218737

1. Spin glasses--Mathematical models. 2. Statistical mechanics.

3. Neural networks. I. Title. II. Series.

QC176.8.S68D68 1994

538'.4--dc20

94-35624

CIP

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Printed in Singapore.

Preface

This book is based on the lecture course I give for the graduate students of the Landau Institute for Theoretical Physics. It is assumed to be self-contained and understandable for any student having basic knowledge in theoretical physics and statistical mechanics.

The main idea of this book is to describe in simple terms rather new scope of the statistical mechanics, known by the title "Spin-Glasses", dealing with the systems in which the quenched disorder is the dominant factor. The emphasis is made on a general qualitative picture based mostly on the results obtained for the mean-field theory of spin-glasses with long-range interactions. The point is that at present the concept of the physics of the spin-glass state can be formulated, in a sense, apart from those artificial models for which it has been originally derived. Moreover, now it is obvious that the problem of spin-glasses has appeared to be much more general than that of the original studies of the low temperature properties of the random magnets. It includes the whole spectrum of problems from those of the optimizations in economy to biological systems.

The history of the subject is skipped off in this book. For that reason the number of "historical" references will be minimal. It is mainly the resulting state of affairs which I suppose to describe here.

The book is composed as follows. In the first two Chapters almost without any calculations, it is explained what the problem is, and modern understanding of the physics of the spin-glass state is formulated in general terms.

In the Chapters 3-10 the "magic" of the replica symmetry breaking scheme is demonstrated and the physics behind it is discussed. This part contains the detailed derivation of the physical picture of the spin glass state for the model of spin-glasses with the long-range spin-spin interactions. In the Chapter 8 the theory based on the scaling properties of the space of spin-glass states is discussed. Besides, in the Chapter 9 recent experiments on real spin-glasses are briefly described to demonstrate how this a bit abstract physics can be really measured.

The final four Chapters are devoted for the so-called, statistical models of neural networks, where the emphasis is made on the statistical mechanical approach based on the methods developed in the mean-field theory of spin-glasses.

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